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Air Toxics Control 'Situation Room'

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16. ABSTRACT The paper describes one component of the Environmental Protection Agency's (EPA's) efforts to assist state and local environmental agencies and its own regional offices in response to their increased responsibilities for planning, evaluating, and approving control approaches for reducing emissions of volatile organic compounds (VOCs) and hazardous air pollutants (HAPs). This component is EPA's air toxics control "situation room" (SR). This is a complex and difficult job, and EPA's guidance and assistance are often sought. Hundreds of sources emit thousands of ozone-producing and toxic pollutants in the U.S. VOCs, emitted to the atmosphere in large quantities, react chemically in the presence of sunlight to form ozone. While adverse health effects result from exposure to ozone, adverse effects are also associated with direct human exposure to the organic pollutants themselves. The health impacts from exposure to HAPs include neurological, behavioral, reproductive, and carcinogenic effects. A major concern is the possibility that some of these compounds may cause cancer. In addition, these toxic air pollutants damage materials and cause crop/forest losses. Thus, state and local environmental officials must also assume responsibility for protection people and the environment from the effects of these pollutants.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Pollution	Pollution Control	13B 06E
Carcinogens	Stationary Sources	04A
Air	Air Toxics	06T
Toxicity	Situation Room	07B
Ozone	Volatile Organic Compounds (VOCs)	07C
Organic Compounds		20M
Volatility		

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AIR TOXICS CONTROL "SITUATION ROOM"

by

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INTRODUCTION

In recent years, state and local environmental agencies have had to take increased responsibility for planning, evaluating, and approving control approaches for reducing emissions of volatile organic compounds (VOC's) and hazardous air pollutants (HAP's). This is a complex and difficult job, and the agencies have frequently sought guidance and assistance from the U.S. Environmental Protection Agency (EPA) to get the job done.

This paper describes in detail one component of the EPA effort to assist the state agencies and regional offices. This component is the air toxics control "situation room" (SR).

BACKGROUND

There are hundreds of sources emitting thousands of ozone-producing and toxic air pollutants in the U.S. Figure 1 shows national VOC emissions by source category for the year 1985.(1) The figure shows that: (1) total VOC emissions exceed 19 million tons per year, (2) area sources emit about 7 times as much VOC's as point sources, (3) the majority of area source emissions are from non-mobile stationary sources, and (4) solvent evaporation contributes 50 percent of total emissions from non-mobile, stationary area sources.

Figure 2 shows the sources that make up the "solvent evaporation" category.(1) It is interesting to note that the "other" sub-category, which includes consumer solvents, contributes 1.7 million tons (1.55 million Mg) of the 4.7 million tons (4.29 million Mg) or 36 percent of the total emissions from this category. Table 1 provides data on consumer solvent emissions for the state of California. The table clearly shows that products we often take for granted can make significant contributions to atmospheric VOC loadings. For example, the California data show that hair sprays contribute more than 8,000 tons per year to the 68,843 ton total in that state.

Figure 3 shows the "top 14" VOC's on a mass emissions basis.(2) Four of the top 14 (formaldehyde, benzene, perchloroethylene, and trichloroethylene) also are entries on EPA's list of 21 "high probability carcinogens" (Table 2).

VOC's, which are emitted to the atmosphere in large quantities (Figures 1 and 2), react chemically in the presence of sunlight to form ozone.(3) While adverse health effects result from exposure to ozone, adverse effects are also associated with direct human exposure to the organic pollutants themselves. The health impacts from exposure to HAP's include neurological, behavioral, reproductive, and carcinogenic effects.(4,5) A major concern is the possibility that some of these compounds may cause cancer.(5) In addition, these toxic air pollutants cause materials damage and crop/forest losses. Thus, state and local environmental officials must also assume responsibility for protecting people and the environment from the effects of these pollutants.

In response to studies which correlated human health effects with exposure to ozone, EPA's Office of Air and Radiation has established a national ambient air quality standard (NAAQS) of 0.12 ppm for ozone. This standard is exceeded in more than 60 areas nationwide.(6)(7) This, coupled with the fact that some areas may not be able to attain the standard for the next 20-30 years, causes serious concerns for human health and welfare. These concerns are heightened by the fact that some scientists are calling for an even more stringent standard. State and local officials in the ozone non-attainment areas are faced with the complex and challenging task of developing and implementing plans which will bring their areas into compliance with the NAAQS on a specific schedule, as well as evaluating permit applications from facilities which may emit toxic pollutants which are also ozone precursors.

THE EPA RESPONSE

In response to requests from state and local agencies for technical and engineering assistance with control issues related to VOC and HAP emissions (see Figure 4), EPA has established programs to provide the needed assistance. These programs include the Control Technology Center (CTC) and the Air Toxics Control Rapid Response Program. The SR is one component of the Rapid Response Program.

DESCRIPTION OF THE SITUATION ROOM

EPA's Air and Energy Engineering Research Laboratory (AEERL) is continuing to establish a framework for rapid response to state and local agency needs relative to permitting and other support for VOC and HAP control. The framework incorporates the CTC, existing laboratory research capabilities for carbon adsorption and corona destruction, laboratory facilities for the investigation of woodstove catalysts and other catalysts, and the SR.

The SR is a centralized, supervised facility providing immediate access to state-of-the-art air pollution control computer models. The SR currently houses extensive computer hardware, including an Apple Macintosh II, an IBM PS-2 Model 80, an IBM AT, and a portable Compaq-286 computer. The SR computers will be incorporated in a multi-user network, allowing access to the facility by most of the engineers in AEERL's Air Toxics Research Division directly from their personal work stations. The SR will also include computer terminals connected to the VAX system (9600 baud) and to the EPA Environmental Research Center's mainframe computer.

Control technology computer models are currently being collected, installed, and debugged, and it is expected that the SR will be operational by October 1989. The models will include:

- Interactive ESP Models, Version 3.2
- EPA/GCA Baghouse (Fabric Filter) Model

- In-stack Opacity Calculator, Version 1.2
- Plume Opacity Prediction Model
- ESP Section Failure Model, Version 1.0
- Flyash Resistivity Predictor, Version 3.0
- Cost Model for ESP's, Baghouses, and Venturi Scrubbers, Version 1.1
- Spray Dryer SO_x Removal Model
- Venturi Scrubber Model
- High Temperature Sodium Depletion Resistivity Model
- Carbon Adsorption Model for VOC Control
- Catalytic Oxidation Model for HAP Control
- Control of Air Toxics (CAT) Advisory System
- Control Technology Center Database
- Accidental Releases Analysis Model

In addition to these "on site" model capabilities, the SR will allow access to models and data base systems which are not yet available for personal computers via linkage to the VAX and mainframe computers.

SITUATION ROOM INTERACTION WITH THE CTC

The SR will supplement the capability of the CTC to meet its responsibilities to provide technical guidance and engineering assistance to state and local environmental agencies. As an additional tool for achieving the CTC's objectives, the SR will operate under the policies and procedures which have been established for the CTC. The role of the SR and its relationship to the CTC are shown in Figure 5. Hotline calls, which are to be handled in 1-2 days (the "routine" manner), will be assigned to a project officer. The project officer may prepare a response or ask the CTC co-chairs to seek assistance from the SR in preparing a response. In either case, the response is delivered to the requestor within the specified time period by the project officer.

If the project officer deems the request not to be "routine," the project officer informs the CTC co-chairs who then assign the request to a project team. The project team develops the response in the most expeditious manner, including the possibility of utilizing the capabilities of the SR and EPA/AEERL's associated National VOC/HAP Laboratory. In either case, the response is delivered to the requestor by the project team.

SITUATION ROOM BENEFITS

Figure 4 shows the extensive use of the CTC hotline by state and local agencies. Many of these requests for assistance can be handled quite effectively through use of the computer model capabilities in the SR. The figure also shows a growth trend which is indicative of the need for this kind of assistance at the state and local level. The growth trend also suggests that EPA's efforts to provide technical guidance and engineering assistance are well-received and effective.

The SR will enhance EPA's ability to provide rapid responses to the increasing numbers of requests for engineering guidance being received from state and local agencies, regional offices, and regulatory program offices. The SR will:

- improve significantly EPA's information transfer capabilities
- support the Agency policy of increased state and local responsibility for local air pollution concerns
- ensure the availability of the latest technical information for informed decision making at the local level

These goals will be accomplished by using the capabilities assembled in the SR to provide rapid aid to state, local, and regional office personnel who are evaluating permit applications, developing state implementation plans (SIP's), and making policies affecting VOC and HAP emission limits. In these ways, the SR can make significant contributions to the national effort to bring ozone non-attainment areas into compliance with the NAAQS for ozone and to the effort to reduce adverse health effects resulting from exposure to VOC's and HAP's.

In addition, the SR provides EPA with a data base of state and local problems, along with alternative solutions which can be shared as needed with other localities which encounter the same or similar problems. The result will be a significant contribution to the mitigation of the adverse environmental effects of VOC's and HAP's for at least the next decade.

SITUATION ROOM CASE STUDY

One of the computer models in the SR is the Control of Air Toxics (CAT) Advisory System.(8) CAT is a PC-based program, based on the HAP Manual (9), which has been designed to assist state and local agencies review permit applications and perform design and cost calculations for control technologies such as thermal incineration, carbon adsorption, flares, fabric filters, ESP's, and venturi scrubbers. CAT was developed jointly by EPA's Control Technology Center and the New Jersey Department of Environmental Protection. The following case study demonstrates the use of CAT.

Example Case Statement

On March 23, 1989, a representative of a state agency called the SR manager with a request for assistance in evaluating the design of a carbon adsorber to control VOC emissions to the air resulting from a gasoline spill. Since an immediate response was needed, it was assumed that butane, which makes up approximately 40 percent of the gasoline vapor, was representative of all the VOC emissions to be controlled from this spill. With this assumption, the following information was available:

- The emission stream consists of air contaminated with gasoline vapors (assumed to be butane).
- The emission stream flow rate to the carbon adsorber is 200 scfm (5.7 m^3/min).
- The concentration of butane in the emission stream is 1,000 ppm.
- The relative humidity of the emission stream is 40 percent.
- The butane is to be recovered by a one-bed carbon adsorber which has a removal efficiency of 95 percent.

The person at the clean-up site needed to know whether a carbon adsorber operating at 95 percent removal efficiency would be a reasonable control choice for recovering the gasoline vapors. Specific questions were: (1) Is the choice of control technology appropriate? (2) Is the control technology capable of controlling the specified emission stream at the efficiency desired? (3) What mass of carbon should be used? and (4) What costs will be associated with the use of this control technology in this situation? CAT is a valuable aid to the reviewer in answering these questions. The use of CAT for this purpose is illustrated below.

Example Case Assessment by CAT

The CAT program is loaded into the computer and accessed. A title page and preface material are displayed. When the user presses the [ESC] key, the Main menu appears, and use of CAT may begin.

The first option on the Main menu is Plant. When the Plant option is selected, a form is displayed in which the user enters the name, location, phone number, and contact person for the plant to be evaluated.

The Stream option of the Main menu is selected to input information about the emission stream. The emission stream may contain organic vapor, inorganic vapor, organic particulate, or inorganic particulate. To select the type of emission stream being evaluated, use the Type option in the Stream menu. Since the example case involves butane, select "organic vapor" from the pop-up menu which is displayed when the Type option is selected.

The Parameter option allows the user to input data regarding the general physical nature of the emission stream. The pop-up menu in the Parameter option looks like this:

Emission Stream:

Parameter	Applicant	Calculation	Checked
Maximum flow rate (scfm)	200	200	
Pressure (mmHg)		760	
Temperature (degF)		90	
Heat content (Btu/scf)			
Oxygen content (%)			
Moisture content (%)			
Relative humidity (%)		40	
Are halogenated organics present? (Y/N)		N	
Are metals present? (Y/N)		N	

To input or change the values on the display, choose a parameter from the pop-up menu by highlighting the parameter with the cursor pad and pressing [Enter]. A parameter form will pop up on the display, allowing the user to enter values for the parameter for the fields shown above. Also in this form is a Recommended Value field. This field may contain some default value to be used in the Calculation Value field if none is available from the applicant. CAT will recommend default values for some of the more difficult-to-find values, but for the most part this field will be blank. Note that not all the parameters in this menu require a value. Whether a parameter requires a value will depend on the type of control device selected.

Next, the user should specify which HAP's exist in the emission stream and the physical parameters for each. The HAP option of the Stream menu is designed to help the user do this. There are four options under this sub-menu: Generate, Review, Add, and Delete. CAT contains a data base that identifies pollutants which may be associated with different Standard Industrial Classification (SIC) codes. The Generate option accesses this data base. The user selects a SIC code by highlighting the desired code and pressing [Enter]. After a moment, CAT displays a list of pollutants which are typically contained in the emission stream. This display is also a pop-up menu which allows the user to edit the parameters for any pollutant.

The Review option allows the user to review the pollutants which have been selected as likely components of the emission stream. When the Review option is chosen, a list of HAP's appears on the screen, and the CAT analysis can be continued, with these pollutants as inputs to the program.

The Add option enables the user to add an air toxic to the emission stream from a data base in which CAT stores several hundred species. The air toxic is selected by highlighting the pollutant from the menu and pressing [Enter].

The Delete option lets the user remove an air toxic from the emission stream.

For this example case, butane was selected from the list of air toxics by using the Add option. The physical parameters for this pollutant in CAT would be displayed on the pop-up menu as:

Hazardous Air Pollutant: 106-97-8 BUTANE

	Applicant	Calculation	Checked
Inlet HAP concentration (ppmv)	1000	1000	
Molecular weight (lb/lb-mole)		58.12	
Specific heat equation constant A		3.884	
Specific heat equation constant B		73.35	
Specific heat equation constant C		-22.655	
HAP concentration (% mass)			
Antoine equation constant A		6.80896	
Antoine equation constant B		935.86	
Antoine equation constant C		238.73	
Heat of vaporization (Btu/lb-mole)		9625.909	

The user may have to enter some missing data on this pop-up menu. The data to be entered depend on the pollutant selected and the amount of data CAT has stored on that pollutant in the data base.

The last option on the Stream menu is Clear. This option erases all stream data for the application currently in the computer. The Clear option is particularly helpful when the user wants to review another stream from the same plant without retyping the plant identifying data.

The Device option in the Main menu allows the user to enter information pertaining to the control device being employed to remove the HAP from the air flow. There are two options associated with the Device menu: Type and Parameter. When the Type option is selected, a pop-up menu containing several control devices is displayed on the screen. The types of devices displayed depend on the category of emission stream type selected in the Stream menu. At this point, the user selects the type of device to be evaluated. For this example case, the control device selected was "carbon adsorber." Note that, once a device type has been selected, choosing another device destroys any device data which may have been entered.

The Parameter option of the Device menu is used to enter the design and cost related parameters for the device. For our example, the pop-up menu associated with this option is displayed as:

	Applicant	Calculation	Checked
DESIGN RELATED PARAMETERS.....			
Removal efficiency (%)		95	
Adsorptive capacity (lb HAP/100 lb carbon)		10	
Number of beds		1	
Cycle time for adsorption (hr)		12	
Cycle time for regeneration (hr)		1	
Stream velocity through the bed (ft/min)		100	
Steam ratio (lb steam/lb carbon)		1	

Steam inlet temperature (degF)	240
Condensed steam outlet temperature (degF)	120
Cooling water inlet temperature (degF)	50
Cooling water outlet temperature (degF)	150
Carbon bed density (lb/ft^3)	30
Cycle time for drying and cooling (hr)	.25
Latent heat of vaporization (Btu/lb)	970
Average specific heat of water (Btu/lb-degF)	1
Overall heat trans. coeff. ($Btu/hr-ft^2-degF$)	150

COST RELATED PARAMETERS.....

Value of recovered product ($/lb)	.14
Duct cost ($/linear ft)	100
Stack capital cost ($)	3300
Length of duct (ft)	100
Total pressure drop (in H_2O)	6
Average equipment life (yr)	10
Operator labor requirements (hr/shift)	.5
Maintenance labor requirements (hr/shift)	.5

The user must enter design and cost parameters in order for CAT to complete the calculations. The CAT Tutorial Manual (10) contains input tables with values required for calculation. Values are consistent with the HAP manual.(9) As with the other pop-up menus, selecting any parameter causes a parameter form to appear. Once the parameter form is displayed, the user can either enter or change the value of the parameter. On some of the parameter form fields, help may be available from the CAT program. From any field, simply press the help key [F1] and the text will be displayed in the lower portion of the screen. While in the help window, the user may scroll the text by using the arrow keys. To turn help off, press [F1] again.

The Review option of the Main menu allows the user to calculate and view the results of the calculation performed by the CAT program. The Review sub-menu has four options: Evaluate, Cost, View, and Print. The Evaluate option displays two sets of results on the screen: (1) Intermediate Results, a list of intermediate values computed by CAT to help the user trace the calculations performed by CAT and (2) Permit Evaluation, a display which shows the size of the device as calculated by the CAT program. For the example, this display is shown as:

Intermediate Results for BUTANE:

HAP_o =	50
Abed =	2.08
Vcarbon =	13.7
Hload =	6.57E+005
delta TLM =	79.6
Qfg =	200

Permit Evaluation:

Carbon requirement (lb)	411
Bed diameter (ft)	2
Bed depth (ft)	7
Steam flow rate (lb/min)	9
Condenser surface area (ft^2)	55
Cooling water rate (gal/min)	13
Recovered product (lb/hr)	2

The Cost option displays the total capital investment and components of the annualized cost. For the example, this display is:

Total Capital Investment (June 1985 Dollars): 36947

Direct Operating Costs

Electricity	126
Steam	23406
Water	2012
Operator Labor	6197
Operator Supervision	930
Maintenance Labor	6197
Maintenance Materials	6197
Replacement Labor	158
Replacement Parts	158

Indirect Operating Costs

Overhead	8089
Property Tax	369
Insurance	369
Administrative	739
Capital Recovery	6022

Net Annualized Cost (June 1985 Dollars): 60971

As shown in the display, all dollar amounts are in June 1985 dollars.

The View option allows the user to preview any part of or the entire report before it is printed. The Print option sends the output either to a printer or to be copied as an ASCII file on a disk. View and Print produce exactly the same results; only the destination of the output is different.

Summary of Example Case Assessment

In a matter of a few minutes using CAT, the SR manager was able to give the state agency representative a ball park assessment of the validity of the use of the proposed control technology for capturing the vapors from the gasoline spill. The assessment provided: (1) validation of the selection of a carbon adsorber for this application, (2) the amount of carbon required to achieve approximately 95 percent capture efficiency, (3) approximate dimensions of the carbon bed, (4) steam and cooling water requirements, (5) the rate of recovery of the gasoline vapor, and (6) estimated costs associated with the control facility.

In processing a separate request from a permit reviewer in one of the EPA Regional Offices, a carbon adsorber was found to be unacceptable as the control approach due to exorbitant costs associated with the facility. The permit application stated that a carbon adsorber would be used to control 1300 ppmv hexane in a contaminated stream with a flow rate of 52,000 scfm (1473 m^3/min). CAT predicted that six carbon beds containing a total of 7 million lb (3.2 million kg) of carbon would have been required to achieve 95 percent removal efficiency. The capital investment would have exceeded $33 million, and the net annualized cost would have been $46 million.

CONCLUSION

The "easy fixes" for the control of VOC's and HAP's have, for the most part, been expended. Standards have been developed and promulgated for the large point sources which emit more than 100 tons (91 tonnes) per year. We are left with a myriad of smaller sources which, when considered alone, contribute a small percentage of the total atmospheric loading. However, their combined emissions make up a significant percentage of atmospheric loadings and contribute to the serious and worsening problems of ozone non-attainment, stratospheric ozone depletion, and adverse human health effects from direct exposure to HAP's.

In the face of the unprecedented technical challenge presented by the complex mix of VOC's and HAP's in the environment, EPA is developing and implementing a comprehensive engineering program aimed at providing the means for achieving environmental goals. The engineering research program is based on multiple approaches for VOC control, including prevention, product management, process management, engineering assistance, and technology transfer. The program should produce the tools needed to deal effectively with the environmental problems associated with the emissions of VOC's and HAP's to the atmosphere. The SR has the potential to make a significant contribution to this goal.

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Table 1. VOC Emissions from Consumer Products in California

Category	VOC Emissions, tons/year
Paints, primers, varnishes (aerosols)	11,408
Hair sprays	8,095
All purpose cleaners	6,463
Insect sprays	5,558
Car polishes & waxes	4,625
Room deodorants & disinfectants	4,650
Consumer adhesives	3,830
Caulking & sealing compounds	2,380
Moth control products	2,098
Window & glass cleaners	1,970
Herbicides, fungicides	1,803
Personal deodorants	1,614
Auto antifreezes	1,165
Carburetor & choke cleaners	1,051
Brake cleaners	1,032
Engine degreasers	1,088
Engine starting fluids	949
Rug & upholstery cleaners	930
Lubricants & silicones	913
Metal cleaners & polishes	660
Waxes & polishes	621
Tile & bathroom cleaners	590
Pharmaceuticals	550
Hair styling mousses	543
Windshield deicers	501
Insect repellents	396
Starch & fabric finishes	365
Auto cleaners	354
Floor waxes or polishes	309
Colognes	303
Shaving lathers	271
Animal insecticides	255
Aftershaves	205
Undercoatings	188
Oven cleaners	185
Shoe polishes, waxes & colorants	183
Paints--other related products	170
Perfumes	135
Spot removers	127
Waxes & polishes--liquids	97
Hair care products--shampoos	89
Carpet deodorizers	69
Suntan lotions	41
Depilatories	11
Antistatic sprays	3
	68,843

Table 2. "High Probability Carcinogens" Determined by EPA's Office of Air Quality Planning and Standards

1. Acrylonitrile
2. Arsenic
3. Asbestos
4. Benzene
5. Beryllium
6. Cadmium
7. Diethyl Nitrosamine
8. Dimethyl Nitrosamine
9. Dioxin
10. Ethylene Dibromide
11. Ethylene Dichloride
12. Ethylene Oxide
13. Formaldehyde
14. Nickel
15. N-Nitroso-N-Ethyl Urea
16. N-Nitroso-N-Methyl Urea
17. Perchloroethylene
18. POM
19. Trichloroethylene
20. Vinyl Chloride
21. Vinylidene Chloride

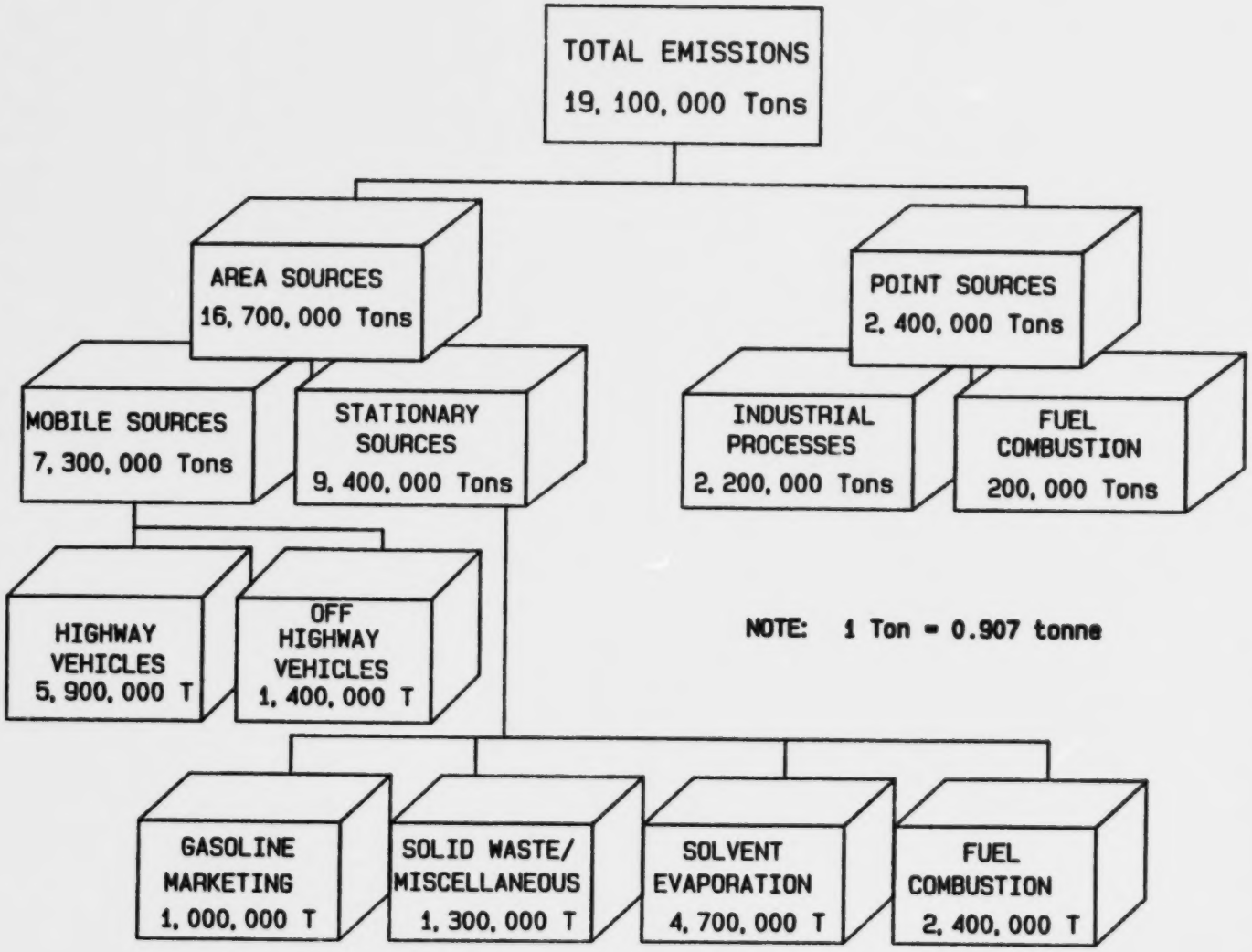

Figure 1. National VOC emissions in 1985 by source category.

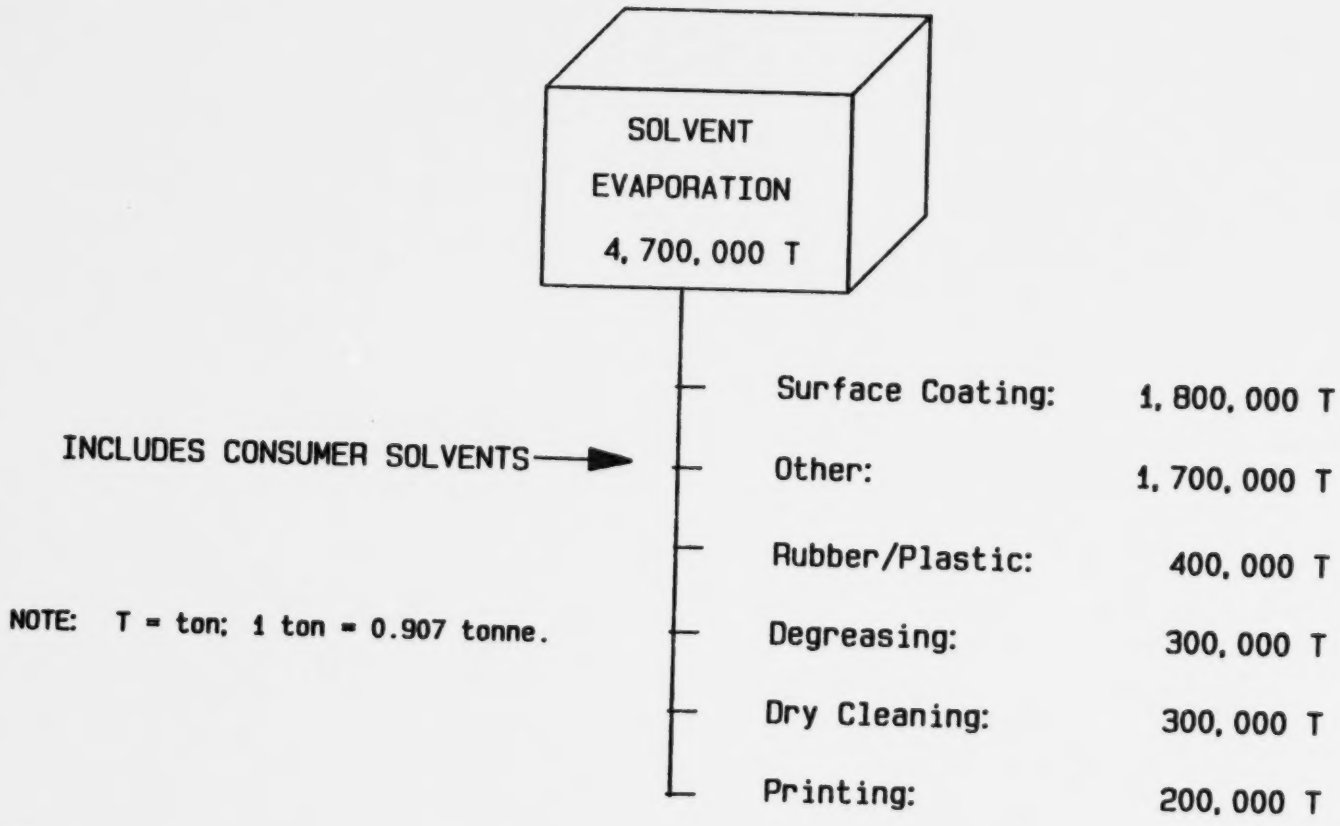

Figure 2. VOC emission sources which comprise the solvent evaporation source category.

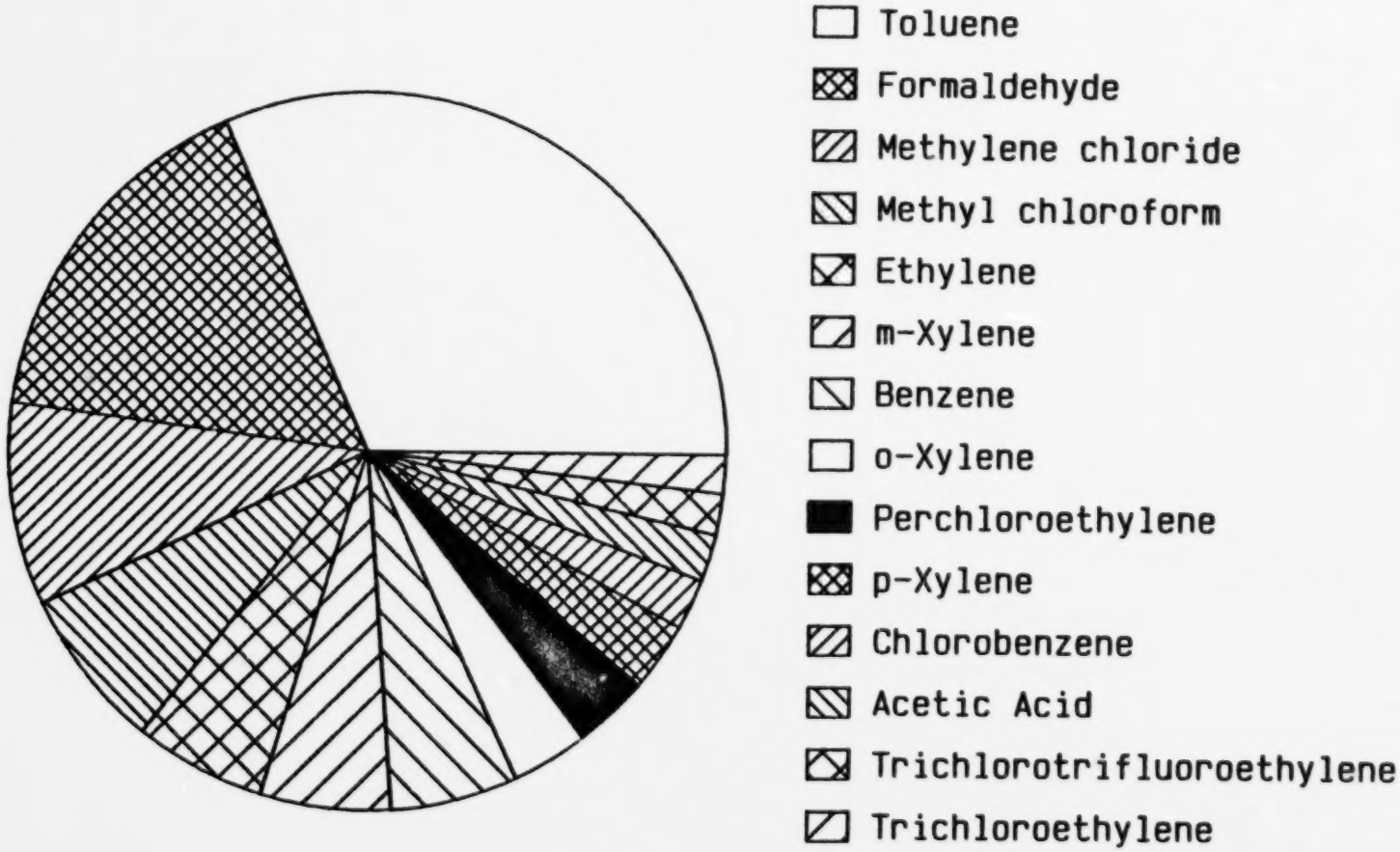

Figure 3. Top 14 VOC/HAP chemicals on a mass emissions basis.

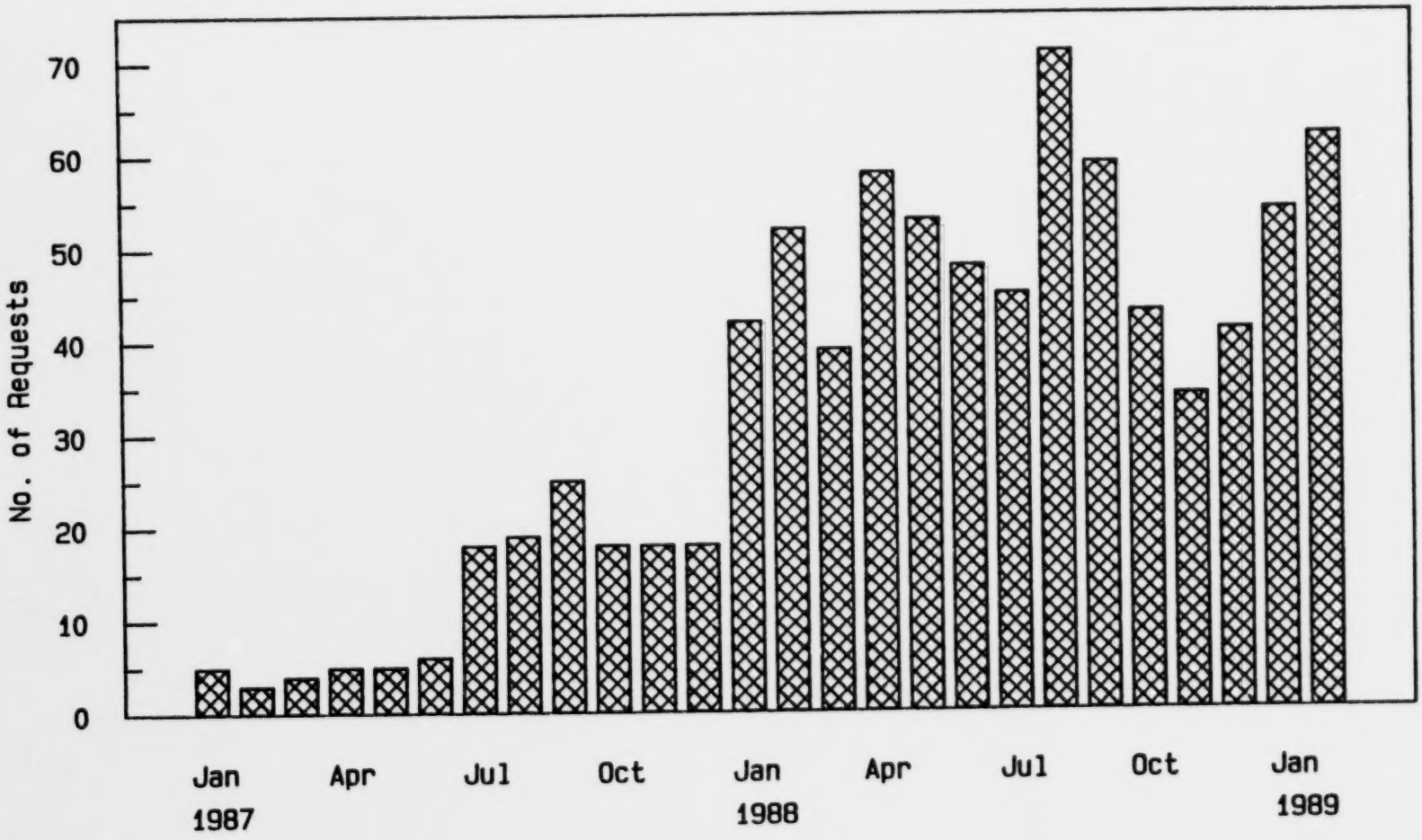

Figure 4. Telephone requests for assistance (excluding requests for copies of existing documents) made by state and local environmental officials and others to EPA's Control Technology Center Hotline.

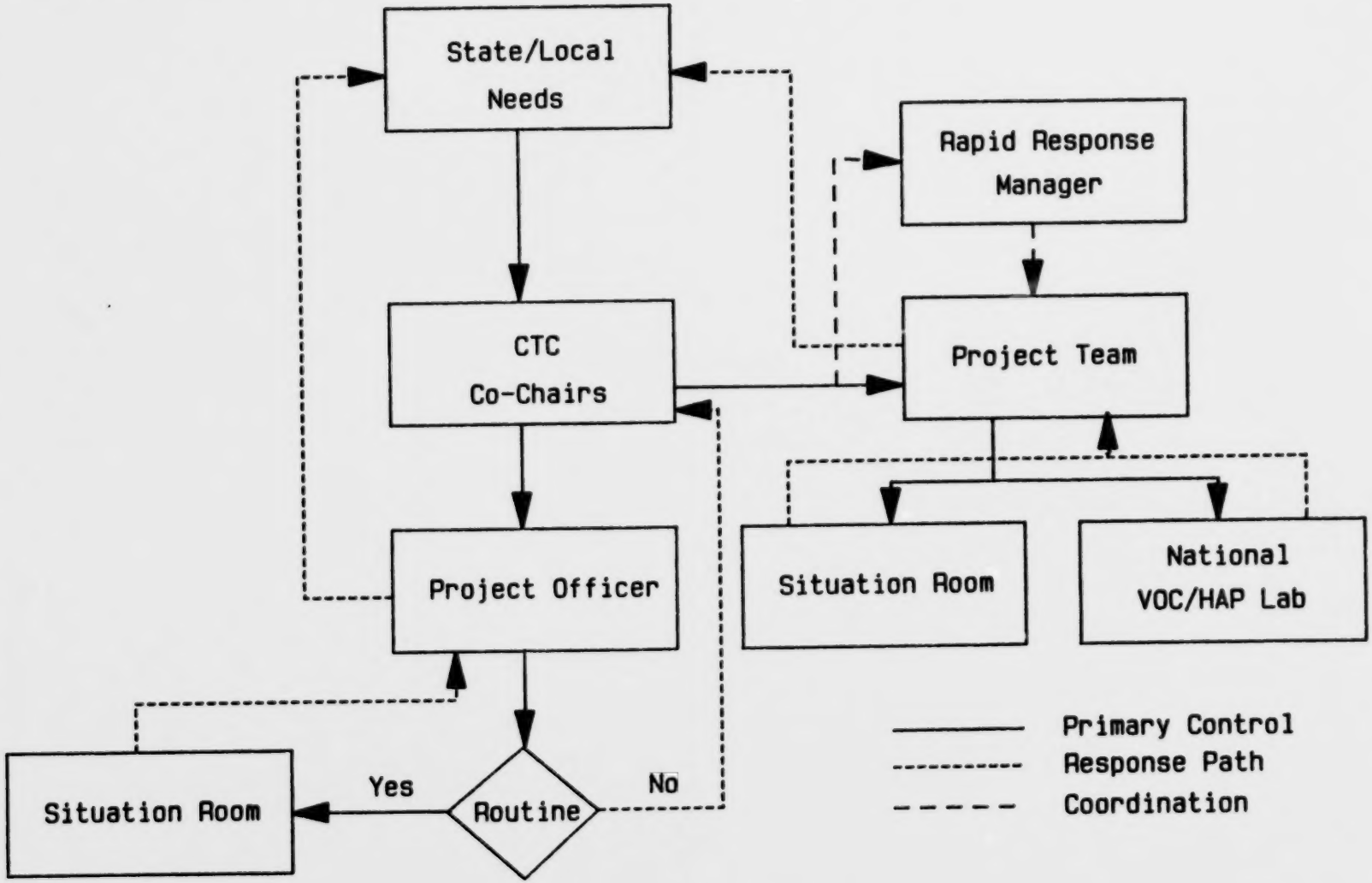

Figure 5. Situation Room interaction with the Control Technology Center.